GIS and Scientific Workstations

Requirements Study and Proposal for a Dedicated Catalog in the Strategic Sourcing Initiative

Prepared by:

Robert Yoha, Research Program Specialist III-GIS
James Hoppers, Information Systems Analyst (Specialist)
Department of Conservation, Office of Technology Services

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Resources Agency

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TABLE OF CONTENTS

PAGE

TABLES

APPENDIX

EXECUTIVE SUMMARY

This report recommends establishing a standard configuration of workstations for geographic information system (GIS) and other scientific computing activities, to be available via a dedicated catalog in the State's Strategic Sourcing Initiative (SSI).

Problem

- The present SSI desktop computing catalog does not support the functional requirements require by the State's GIS and scientific user community.
- GIS and scientific user needs for computer capability, outclass the desktop PCs available from the standard desktop compliment, which was developed for an office environment.
- GIS and scientific programs throughout State operations are now unable to procure a suitable higher performance workstation which is negatively impacting their work.
- A more technically capable desktop workstation is required for GIS and scientific applications; a method of procurement is needed other than the exemption process.
- Procuring components from multiple vendors creates cross-vendor and support issues.

User Needs

A range of GIS and scientific computing requirements, points to three levels or classes of workstation capability. These three classes of workstations can be simply summarized.

Entry Level
Simple mapping and analysis tasks, such as map construction and publication, simple spatial queries, data entry and maintenance.

Mid Range
More complex operations such as nested topological queries, interaction with and large data sets which require more capable computing ability. Also engineering design, computer aided drafting and architectural drawing.

High Performance
Demanding applications such as 3-D analysis, terrain and hydrologic modeling, image classification and remote sensing, stereo viewing for visualization and photogrammetry -- require high performance components.

These three classes are driven by task specific functions required by GIS and scientific users.

Recommended Actions

It is recommended to establish three classes of GIS/Scientific workstations, available via a dedicated catalog supported by the Department of General Services' Strategic Sourcing Initiative.

It is also recommended that the GIS/Scientific Workstation Catalog, be supported by a single vendor to facilitate configuration, procurement, maintenance and technical support.

SCOPE

The goal of this report is to create a dedicated SSI based catalog, to provide high performance workstations for geographic information system (GIS) and scientific users.

This report focuses on the following:

- Inventory of GIS/Scientific user's functional needs.
- Identification of key software and operational requirements.
- Definition of a workstation configuration series based on user needs.
- Establishment of a dedicated catalog for high performance workstations in the Strategic Sourcing Initiative, to service the State's GIS/Scientific community.

The intent of this report is to identify and establish a standard configuration, or to be more specific, three class of workstations for use in GIS and other scientific computing activities.

INTRODUCTION

GIS and scientific users are a small percentage of a much larger computing population in California State government. Though their numbers are small, GIS and scientific users are widely spread throughout State government and they provide important, often mission critical support. They are in air quality, emergency response, health, transportation, land and water use, timber management, fish and wild-life, to name a few.

Decisions and activities based on spatial and scientific analysis are key to all areas of State government operations. The following examples are some of the many activities, which rely on use of high performance workstations operated by GIS programs and scientists.

- Responding to and mitigating flood risk to metropolitan and rural areas.
- Planning for and responding to forest and wild land fires.
- Planning for, responding to and recovering from oil spills.
- Mapping and zoning geologic and seismic hazards, for public safety.
- Monitoring land use changes to plan for present and future delivery of water.
- Tracking urbanization to preserve prime farmland and open space.
- Protecting surface and ground water quality, and mitigating contamination.
- Analyzing health issues and medical services, to prevent widespread outbreaks.

The work this small group is tasked with -- is significant in terms of the responsibility placed on the information -- generated by GIS and scientific programs in State service.

OPPORTUNITY (PROBLEM)

The Department of General Services SSI standard complement is designed to meet the needs the every day business office environment.

The majority of desktop computers are used for document, budget and email tasks. A Microsoft Power Point presentation represents a demanding user need for computing capability in an office environment.

The SSI office based standard complement addresses everyday business needs. However, even the top-most office based configuration, is lacking if used for a GIS or scientific application.

The SSI's standard complement does not adequately address the rather specialized needs of GIS programs and the scientific community. GIS and scientific applications place a much greater demand on functional requirements, far above what is sufficient for an office environment.

A more capable, high-performance standard complement is needed for the GIS and scientific community. The DGS SSI needs to include a higher performance standard compliment workstation series for this specialized State user community.

USER NEEDS SURVEY

A survey of GIS users was conducted, inquiring as to their functional requirements for system configurations. Appendix A contains the results of this survey. The California Environmental Resources Evaluation System Program (CERES) coordinated this survey. The large number of responses from a wide range of departments, indicates the results are a fair representation of user needs. Table 1 summarizes responses for workstation requirements.

Table 1. Overall User Requirements for a GIS/Scientific Workstation

Component	DGS Desktop	GIS and Scientific Requirements
Chassis:	Tower	**OK**
Processor:	Intel Pentium® 4 3.0GHz	Single and dual Intel Pentium and XEON processors; option for AMD Athalon 64 and Dual-Core processors.
Cache:	800 MHz FSB, 1Mb Cache, or equivalent	800 MHz FSB, 2 MB L2 Cache
Memory:	1024MB DDR400 Non-ECC	2 to 4 GB, 533 MHz, DDR2 ECC SDRAM
Keyboards:	PS/2 Keyboard, No Hot Keys	**OK**
Monitor:	No Monitor (monitors listed separately; LCDs both DVI & VGA compatible)	19" to 21" display, .24 to .29 dot pitch; LCD 250 nits, 500:1 contrast, 170/170 view angle; 1600x1200 prefered or higher resolution; 75 Hz min. refresh rate 85 Hz preferred for CRT; certified video cards available.
Video Card:	Integrated DVMT Video	256 MB standard and up to 512 MB memory; OpenGL compliant or equivalent card & drivers, dual VGA or Dual DVI with DVI to VGA Adapters. nVidia Quadro FX 3400 or FX 4500 or other to meet application software requirements.
Boot Hard Drive:	80GB SATA 7200 RPM, Non-RAID	Option for matched 15,000 RPM boot and data drives.
Additional Data Storage:	n/a	One or more 250 to 500 GB SATA2 Hard Drives, SATA2 and SCSI RAID Controllers
Floppy Drive:	1.44 MB 3.5 Inch Floppy Drive (Internal)	**OK**
Operating System:	Microsoft® Windows® XP Professional	Option for Microsoft® Windows® XP Professional x64 edition
Mouse:	USB Optical Wheel Mouse	3-button mouse. Center wheel capable of emulating middle button functionality
Integrated Network Adapter (NIC):	10/100/1000 Ethernet	**OK**
Optical Storage Device:	CD-RW/DVD-RAM +/-R RW Drive; DVD+RW available as upgrade	16xDVD+RW; Supported Writable Media: DVD+R DL, DVD+R, DVD+RW, DVD-R DL, DVD-R, DVD-RW,CD-R, CD-RW
Audio Solution:	Integrated Sound	**OK**
Speaker:	Internal Audio Speaker	**OK**
Hardware Support Services:	3 Year Limited Warranty plus 3 Year NBD On-Site Service	**OK**
I/O Ports:	2x USB 2.0 (front), 4x USB 2.0 (back), 1xVGA, 1xSerial, 1xParallel, 1x PS/2 Port, 1xRJ-45, Audio in/out, Mic	4x USB 2.0 (with min. of 1 in front), 1xVGA, 1xDual VGA/DVI, 1xSerial, 1xParallel, 1x PS/2 Port, 1xRJ-45, Audio in/out, Mic
PCI Slots:	Minimum of 1 open PCI slot	Minimum of 3 available PCI slots.

Comparison with GIS/Scientific user requirements shows a need for a more capable system than provided for in the DGS desktop.

The DGS configuration supports seven needs, though these are non-critical such as the keyboard, a floppy drive, network adaptor and speakers.

Departures from the SSI office desktop are: a more capable line of processors; more and error correcting memory; higher performance displays and graphics cards; additional storage and device communication capability; also, a need for certified graphic cards for specialized software.

These more demanding capabilities exceed those required for tasks in an everyday office environment, which were used to define the original SSI desktop configuration.

However, not all GIS and scientific computing tasks are the same; they can be grouped into levels of complexity based on the operations required. Table 2 compares generalized GIS and scientific operations, and matches these to three configurations levels of workstations.

Table 2. GIS Operations and Workstation Configuration

GIS Operations	Workstation Configuration Levels		
	Entry Level	Mid Range	High Performance
Routine Mapping	X	X	
Large Projects	X	X	
Complex Modeling		X	X
Remote Sensing/Image Processing		X	X
3-D Modeling			X
Photogrammetry and Stereo Display			X

There is some overlap between configuration levels. There is an advantage to use a more capable workstation to increase productivity. This is explored in the following section; see the discussion concerning staff productivity in Entry Level and Mid Range operations.

SOFTWARE and REQUIREMENTS

GIS operations are dependent upon software, which accomplishes the necessary tasks to process information, analyze and present results. GIS software and its applications can be very be involved; however, there are three basic operations common to all GIS software, these are important as they are effected by workstation capability.

Common Operations

There are three common compute tasks which all GIS software places on the hardware.

1. Spatial Component
2. Location
3. Visualization

GIS software and data are unique in that a spatial component is involved. An integral part of any task is what is the geographic extent of a particular set of information? Where is it located? What is its proximity or relationship to other features? Calculating a polygon to represent a data set, or series of polygons for several data sets, is extremely compute intensive.

An important step in creating a polygon, is to determine its true location and to compare or relate this to other spatial information. All spatially referenced data must be in its correct position on the earth. This is determined using a coordinate system or map projection routine. If data are not correctly located, incorrect positioning will occur -- resulting in problems and errors.

A critical aspect of GIS software is visualization of the data and resultant analysis. Display of this information is accomplished by the graphics card. The larger and more complex the resultant image or display, the more capable the graphics card must be. A graphics card must also support additional onboard memory to handle larger images efficiently and quickly.

These common operations place a demand on the workstation to compute shapes, calculate correct locations, and to display the resulting information for user visualization and validation.

Survey of GIS Software in Use

A survey of GIS software in State use will find every major manufacture and most of the smaller companies. Compiling a 100% complete list is not within the scope of this report. Appendix 2 contains a listing of the major GIS and scientific software used in State service.

A more useful approach is to compare the major software products along with their requirements for major system components. Table 3 compares widely used GIS software with its optimum components, and then groups these into the three configuration levels introduced in Table 2.

Table 3. Specialized Components for GIS Software

GIS Software	Specialized Requirements				Configuration Level
	Single or Dual CPU	Base Memory	Graphics Card Memory	Matched High Speed Disk Drives	
ArcView - routine operations	single	512 MB	128 Mb	No	Entry Level
MapInfo - routine operations	single	512 MB	128 Nb	No	
MapInfo - intensive analysis	single	1 GB	256 Mb	No	Mid Range
GeoMedia - routine operations	dual	512 MB	256 Mb	No	
GeoMediaPro - intensive analysis	dual	2 GB	256 Mb	Yes	
ArcView Image Analyst	single	2 GB	256 Mb	Yes	
ERDAS - routine image processing	single	1 GB	256 Mb	No	
Web Applications	dual	4 GB	256 Mb	No	
ArcView 3-D Analyst	single	2 GB	512 Mb	Yes	High Performance
ERDAS - intensive remote sensing	single	2 GB	512 Mb	Yes	
ERDAS 3-D modeling & visualization	dual	4 Gb	512 Mb	Yes	
ERDAS - photogrammetry	dual	4 GB	512 Mb	Yes	

Some software manufactures publish minimum system requirements. These are not used here, requirements such as these are in reality a failure point and not realistic in real world applications.

Software is the most important factor in workstation configuration. Selection of software is based on user needs -- to work with and analyze particular kinds of data. Other factors are also considered such as purchase and maintenance cost, operational complexity and staff expertise.

At this point it is useful to explain the specialized requirements and configuration ranges.

CPU

Complex software and operations are now being written to use dual processors to speedup and reduce compute times.

Some companies are also constructing their software to execute as multi-threads. IBM and AMD are addressing this performance requirement with dual processor boards and processors with dual cores. This presents a challenge to the computer workstation manufacture to design an overall system with faster bus speed, disk controllers and drives to support a faster processor.

Base Memory

Once the operating system is loaded, along with additional office, security and network programs, 300 mega-bytes (MB) of memory can be in use. Add to this a requirement for 512 MB of memory for GIS software, and the need for one GB of base of memory can be easily reached even with an Entry Level configuration. The base memory requirement for 512 will soon be eclipsed as one meter imagery with larger file sizes becomes common in GIS and other visualization operations.

Also, error correcting memory is now a necessity and no longer simply an option. Larger compute tasks are prone to failure with non-error correcting memory. Aborts of lengthy program process due to memory error can waste significant amounts of staff time.

Graphics Cards

Visualization is one of the most important operations for both the software and the hardware system. Users are no longer paging through reams of computer printouts, looking for an error.

A graphics card with 128 MB of memory used to be sufficient for an entry level workstation. As higher resolution imagery becomes more common place, files sizes are increasing and require 256 MB or more, up to 512 MB of memory for graphic computations and display.

Graphics card requirements for mid-range operations vary between 256 and 512 MB, depending on the size of the image to be displayed. Some manufactures utilizing image tiling and memory caching to speed up image display, these functions are not found in entry level software.

More complex image processing, 3-D and stereo visualization, engineering and photogrammetric operations, now require certified graphic cards. To successfully operate some ESRI and Leica software, requires specific graphics cards with maximum memory; 640 MB is just now available.

Graphics cards are now taking over many computation tasks once regulated to the main processor. Three dimensional calculations, surface rendering and shading now take place in the graphics subsystem.

Less than 10 tens ago, image processing operations such as these required workstations costing in excess of $250,000. A computer workstation costing $6,000 to $8,000 can now do the same operations and faster, with increased resolution and improved display of information.

Configuration Ranges

There is a small range of overlap up and down between the configuration levels. It is possible to successfully use a more capable workstation for a lower level of task. Using a lower level or an outdated workstation for a higher level task is a risky approach with problems.

There is an apparent grouping of software brands in the high performance configuration level. These software applications require specialized configurations to be operated successfully. The market for specialized software is small, only a few manufactures are in this market segment.

Entry Level Users

An entry level configuration exceeds a high-end SSI standard desktop. Entry level GIS software requires a graphics card with a minimum of 128 MB of video memory and 1 GB of main memory. A better and larger monitor or LCD screen is also required for visualizing and composing maps.

Some State GIS programs prefer to use mid-range capable computers for entry level work, because work can be accomplished quicker with a more capable configuration. In times of doing more with less, a single one-time investment in better hardware pays dividends on a daily basis.

Mid-Range Users

Mid-range users work with larger data sets and more compute intensive operations, hence additional demands are placed on the processor, base memory, graphics subsystem, and attendant hard disk drives. At this level, some software is now being designed to take advantage of multiple processors, to reduce longer compute times caused by increasingly complex software.

The largest number of users falls into the mid-range class. The majority of GIS, scientific and engineering software is fully supported within this mid-range level of workstation configuration.

It is common to find a mid-range workstation in use for entry-level operations, due to the advantage of higher productivity for a slight increase in hardware cost. Complex tasks with smaller file sizes and no need for a specialized graphics card may be undertaken with a mid range workstation -- in this case longer compute time becomes a limiting factor.

High Performance Users

High performance users have the most demanding requirements. In comparison to the lower two levels, this is the smallest number of users, mostly photogrammetrists and advanced GIS users.

High performance users require equipment incorporating the upper ranges of technology. As software becomes more capable with each generation; greater demands are placed on the workstation to complete more complex operations in the same time, or as users hope, less time.

High end software is not only designed for multiple processes, it may also take advantage of multi-threading, both require more memory, larger and faster caching. With larger data sets, disk drive speed and matching drives is common; with the primary drive handling the operating system, a secondary drive for application software, and if possible, a third drive for data.

Cost of Operation and Obsolescence

Lost productivity due to slower hardware processing can result in substantial cost over time.

An Associate Geologist or Research Analyst II can be used as a representative staff position operating a mid-range workstation. Use an average hourly salary of $25, $50 would be more realistic considering other costs. Consider if five minutes out of every hour is lost while a large data file reads and loads, next the image is recomputed and then the display refreshes. This leads to an annual loss of $4,000 or $8,000 if $50 per hour is used. This is more than enough to justify a new replacement or higher performance workstation to maintain productivity.

This scenario will become common place as mapping programs utilize more readily available aerial and satellite imagery with larger files sizes and more intensive image display.

Several years ago, black-and-white three meter resolution U.S Geological Survey digital ortho-photos covering the entire state became available. Image files sizes could be upwards to 250 MBs. Greater demands on were placed on workstations using this imagery, some were replaced or upgraded. Most programs could not replace or upgrade their workstations, staff simply waited.

Within the next year, one meter full color imagery will become available, as a result of a cooperative effort between the State and the USDA National Agricultural Imagery Program (NAIP). File size is expected to double for NAIP imagery. Use of imagery continues to expand, for example multi-spectral imagery was recently used for estimating roof-top solar potential.

Complex projects can create a greater demand on productivity. To generate a 3-D model may require from 20 to 40 minutes, while a series of images along a flight path converted to a video format may consume 8 to 14 hours. Factor in retries and improvements, these projects can take weeks or months. Using an older slower workstation soon becomes prohibitive.

In reality, new computer equipment is faster than a 12 percent improvement in time (fives minutes of an hour). In many cases office staff have their computers replaced about every two years because desktop computers cost less. While more expensive workstations are replaced at four-to-five year intervals. Invisible costs due to lost productivity are higher for a GIS or scientific staffed program compared to an office environment.

WORKSTATION OBSOLESCENCE

Today's replacement can be 50 to 70 percent faster than a two-to-three year old workstation. This quickly explains why workstations become obsolescent by their fourth year. The most mentioned requirement from users, is not technical, rather it is based on useful lifespan.

> "What we purchase today, needs to be advanced enough to have a useful life of at least three to four years."

Most State programs can only replace their workstations after four-to-five years. This places a requirement on the procurement process, to both provide current technology and deliver equipment before it becomes outdated. This request points to a specialized catalog to eliminate the long exemption process for users that must purchase outside of the SSI standard compliment.

A brief review of some of the system requirements so far.

- Faster and more capable processors, dual processors for demanding tasks.
- Error correcting main memory, for some users up to the maximum possible.
- Larger, faster hard disk drives, and if needed matched drives.
- Graphics cards with larger memory, certified for specific applications.

A higher level workstation configuration can be used for lower level operations; however cost of the equipment limits this stepping downward to some extent. As technology advances, it is feasible to re-assign a workstation to lower level tasks. At some point in time, an older workstation becomes obsolete because of a decrease in ability to operate current technology.

DEDICATED CATALOG

What should be available in a catalog dedicated to high performance workstation users? Table 4 presents a comparison of Table 1's workstation requirements merged with today's technology, as they relate to the workstation market place. Vendor availability via the SSI is not considered yet.

Table 4. High Performance Workstation Technology

HIGH PERFORMANCE Technologies	**WORKSTATION COMPARISON**		
	Dell	HP	IBM
Workstation Model	Precision 670	xw9300, xw8200 and c8000	IntelliStation A Pro, Z Pro Workstation
Hyperthreading	**Yes**	**Yes**	**Yes**
Multicore processors	**Yes**	**Yes**	**Yes**
AMD processor products in the high-end line	No	**Yes**	**Yes**
Graphics cards tuned/certified for GIS use, with OpenGL compliance, dual monitor and also stereo capabilities	**Yes**	**Yes**	**TBD**
Dual graphic card build option on the motherboard	NO	**Yes**	NO
Multi-processor capable motherboards for computational-intensive numerical calculations.	**Yes**	**Yes**	**Yes**
All memory cards to include ECC feature, OEM certified	**Yes**	**Yes**	**Yes**
Available RAM to 4GB or greater, OEM installed.	NO	**Yes**	**Yes**
Installed RAID-capabilities, either with SCSI or SATA drives	NO	**Yes**	NO
Hard drive speeds at 15000 RPM or faster with primary drive matched to secondary drive.	**Yes**	**Yes**	**Yes**
Software sectoring and/or virtualization to maximize access speed and stabilities.	**Yes**	**Yes**	**Yes**
optional 64-bit software at the operating system and application level (this is a forecasted need)	**Yes**	**Yes**	**Yes**
ISV certification	**YES**	**Yes**	**Yes**

Observations on Table 4

Computers from Sony and Gateway are not compared here, since they do not offer or support a workstation class product. Gateway desktop computers are available via the SSI, but they do not meet the requirements for a high performance workstation.

Dell computers are not available via the existing SSI standard complement. Some requirements are not meet, memory can only be accessed up to 3 GB, RAID requires a 64 bit server controller to be used. Dell computers could work for entry-level and possibly mid-range, but not for higher performance applications. Dell is not a DGS selected vendor for desktop computers.

IBM manufactures suitable workstations. There is a question as to graphic card performance and certification for high performance and software needs. IBM is not a DGS selected SSI vendor.

HP workstations meet all workstation technology requirements, which are based on user needs and software requirements. HP is in the DGS SSI list of vendors for desktop computers.

Visualization

There is one more critical component, the graphics card and subsystem performance. A further requirement can be stated, a high performance workstation configuration centers on the graphics card and subsystem performance -- which support complex visualization requirements.

Table 5 compares the three vendors noted in Table 4, and evaluates their graphic card and subsystem capabilities -- in regards to successful operations using four key GIS and photogrammetry software programs used for visualization in a high performance configuration.

Table 5. Graphics Card and Subsystem Capabilities

GIS and Photogrammetry Video Sub-System Requirement	WORKSTATION COMPARISON		
	Dell	**HP**	**IBM**
Certified for Leica Photogrammetry and stereo	NO	**Yes**	**TBD**
Certified for Stereo Graphics hardware	NO	**Yes**	**TBD**
Suitable for ERDAS Virtual GIS	**Yes**	**Yes**	**Yes**
Suitable for ESRI 3-D Analyst	**Yes**	**Yes**	**Yes**
maximum video memory in suitable card	256 Mb	640 Mb	640 Mb

User needs determine software which then drives hardware; this is critical for high performance users. Graphic card and system requirements for these key software operations are noted in Appendix D; URLs are listed rather than add more pages with manufacture's documents.

HP meets the high performance requirements for visualization. IBM lists acceptable graphics cards, however, these have not been certified by the software manufactures, for use in IBM workstations. Also -- HP is available via the SSI for desktop computers -- IBM is not.

A recent development is that HP and ERDAS have initiated a cooperative program to test, certify and support graphics cards for use in key software applications. This is an industry first, two major manufactures are working to support a shared need for a third-party critical subcomponent.

RECOMMENDATION

- DGS establish a dedicated catalog in the Strategic Sourcing Initiative to meet the needs of the high performance GIS and scientific user community.

- That DGS consider a single vendor to service this catalog, based on user requirements and the companies available in the strategic sourcing computer equipment initiative.

Appendix A

USER NEEDS INVENTORY

The following tables present responses from the State GIS and scientific user community. A very large number of responses were obtained from a wide range of agencies, which indicates that this information is a fair representation. The CERES Program coordinated this survey.

Desktop

Product Attribute	DGS Workstation -- Description	Departure from Current DGS Offering
Chassis:	Tower	ok
Processor:	Intel Pentium® 4 3.0GHz	Single and dual Intel Pentium and XEON processors; option for AMD Athalon 64 and Dual-Core processors.
Cache:	800 MHz FSB, 1Mb Cache, or equivalent	800 MHz FSB, 2 MB L2 Cache
Memory:	1024MB DDR400 Non-ECC	2 to 4 GB, 533 MHz, DDR2 ECC SDRAM
Keyboards:	PS/2 Keyboard, No Hot Keys	ok
Monitor:	No Monitor (monitors listed separately; LCDs both DVI & VGA compatible)	19" to 21" display, .24 to .29 dot pitch; LCD 250 nits, 500:1 contrast, 170/170 view angle; 1600x1200 prefered or higher resolution; 75 Hz min. refresh rate 85 Hz preferred for CRT; certified video cards available.
Video Card:	Integrated DVMT Video	256 MB standard and up to 512 MB memory; OpenGL compliant or equivalent card & drivers, dual VGA or Dual DVI with DVI to VGA Adapters. nVidia Quadro FX 3400 or FX 4500 or other to meet application software requirements.
Boot Hard Drive:	80GB SATA 7200RPM, Non-RAID	Option for matched 15,000 RPM boot and data drives.
Additional Data Storage:	n/a	One or more 250 to 500 GB SATA2 Hard Drives, SATA2 RAID Controllers, and SCSI RAID Controllers
Floppy Drive:	1.44 MB 3.5 Inch Floppy Drive (Internal)	ok
Operating System:	Microsoft® Windows® XP Professional	Microsoft® Windows® XP Professional x64 edition
Mouse:	USB Optical Wheel Mouse	Wheel must be capable of emulating middle button functionality
Integrated Network Adapter (NIC):	10/100/1000 Ethernet	ok
Optical Storage Device:	CD-RW/DVD-RAM +/-R RW Drive; DVD+RW available as upgrade	16xDVD+RW (available as upgrade, speed unknown); Supported Writable Media: DVD+R DL, DVD+R, DVD+RW, DVD-R DL, DVD-R, DVD-RW,CD-R, CD-RW
Audio Solution:	Integrated Sound	ok
Speaker:	Internal Audio Speaker	ok
Hardware Support Services:	3 Year Limited Warranty plus 3 Year NBD On-Site Service	ok
I/O Ports:	2x USB 2.0 (front), 4x USB 2.0 (back), 1xVGA, 1xSerial, 1xParallel, 1x PS/2 Port, 1xRJ-45, Audio in/out, Mic	4x USB 2.0 (with min. of 1 in front), 1xVGA, 1xDual VGA/DVI, 1xSerial, 1xParallel, 1x PS/2 Port, 1xRJ-45, Audio in/out, Mic
PCI Slots:	Min. of 1 open	Min. of 3 open

Notebook

Product Attribute	DGS Power User Notebook -- Description	Departure from Current DGS Offering
Processor/Cache:	Intel Pentium M 2.0GHz, 400FSB, 1MB Cache, or equivalent	Intel Pentium M Proc 780 2.26GHz
Memory:	1024MB DDR Non-ECC SDRAM (2 DIMMs)	1 to 2GB of 533MHz DDR2 SDRAM memory
Screen Size:	15" TFT	ok
Video Card:	Integrated Video	ATI Radeon X600 128MB video card and drivers
Boot Hard Drive:	40GB ATA-100 5400RPM	ok
Operating System:	Microsoft® Windows® XP Professional	ok
Modem:	Internal 56K Modem	ok
Integrated Network Adapter (NIC):	10/100/1000 Ethernet	ok
Wireless	802.11g Integrated Wireless	ok
Optical Storage Device:	CD-RW	8x DVD+RW
Audio Solution:	Integrated Sound Blaster Compatible	ok
Speaker:	Internal Audio Speaker	ok
Minimum Battery Life:	2 Hours	ok
Weight (in lbs):	Identified after Award	ok
Hardware Support Services:	3 Year Limited Warranty plus 3 Year NBD On-Site Service	ok
Mass Storage Interface:	n/a	USB2 and 1394a (Fireware)

Upgrade/Downgrade Options	DGS Notebook Options -- Descriptions	Departure from Current DGS Offering
Hard Drive:	Upgrade to 60 GB 7200RPM	100 GB 7200 HD
Floppy / Optical Drives:	Upgrade to 3.5 Inch Floppy Drive	ok
Warranty:	Downgrade to 3 Year Limited Warranty	Upgrade to 4 yr warrenty w/accidental damage protection
Miscellaneous:	Add Port Replicator	ok
	Add Docking Station	ok
	Additional Battery (Same base config specs)	ok
	Add Nylon Carrying Case	ok
Value Added Services:	Asset Tagging - Bidder administration of State provided tag (with number)	ok
	Asset Information via Internet	ok
	Imaging	ok
	Self-Warranty Certification	ok
	Disposition/Disposal Services	ok
Video Card:	n/a	Dedicated 128MB OpenGL and Directx 9.0 compliant video card and drivers
Mouse:	n/a	USB Optical Wheel Mouse

Appendix B

MAJOR SOFTWARE IN USE BY STATE AGENCIES

AutoCAD

Bentley MicroStation

ER Mapper

ESRI *
- ArcGIS
- ArcIMS
- ArcInfo
- ArcMap
- ArcSDE
- ArcView
- 3-D Analyst **
- Image Analyst **

Google Earth

Intergraph *
- GeoMedia
- GeoMedia Professional
- GeoMedia Web

Leica *
- ERDAS Professional and Virtual GIS **
- Leica Photogrammetry Suite **
- ORIMA **

MapInfo *
- MapInfo Professional
- Map-X
- Vertical Mapper

PCI

Research Systems
- ENVI
- IDL

SPSS and SAS

SteroGraphics Cooperation

TeleAtlas
(both data and software)

TNT MIPS

* Product suits are too extensive to list here.
** These products require a graphics card that has been certified.

Appendix C

GIS OPERATIONS RELATED TO WORKSTATION CONFIGURATION LEVEL

Examples Used for Illustrations of Workstation Configuration Levels

The following visual examples are from the Department of Conservation, California Geological Survey's Seismic Hazards Zonation Program.

The examples use real tasks to visually represent the three different configuration levels needed for GIS and scientific workstations.

The reason for choosing these specific examples is that this information was readily at hand. More information on the Seismic Hazards Zonation Program can be found at:

http://gmw.consrv.ca.gov/shmp/

GIS and Scientific Information

To understand the extent of the wealth of information produced by this small community, one may access the information via a variety of online Internet based sites.

To explore and learn about information available from State GIS programs, visit the State of California's online GIS web site, the California Environmental Resources Evaluation System (CERES) maintained by the Resources Agency which can be located at:

http://ceres.ca.gov/

An online reference library of GIS and scientific information, maintained per federal and Library of Congress standards, is the California Environmental Information Catalog (CEIC) along with the California Spatial Information Library (CASIL) both maintained by CERES and accessed via:

http://gis.ca.gov/catalog/

An excellent example of interactive spatial mapping is maintained by the Department of Fish and Game. Their online BIOS project contains both public domain and secure information, and can be access via the following link:

http://bios.dfg.ca.gov/

GIS Workstations are Sized to the Complexity of the Task

This series is intended to illustrate a range of simple-to-complex everyday tasks which occur in a GIS program; and, how tasks determine the best fit for sizing capability and cost of a workstation.

It would be possible to use a high performance workstation for all of the following tasks. In reality, program budgets drive the need for sizing a workstation to the complexity of the given task.

Entry Level Example

A simple map is often the end-product of a highly complex scientific analysis process

An entry level workstation can be used to construct a map using data produced by more complex operations. Figure A1 is a Seismic Hazards Zonation Map of the Oakland East Quadrangle in the San Francisco Bay region. The slight tilt of the mapped area is a result of the map projection used, in this case a Transverse Mercator projection.

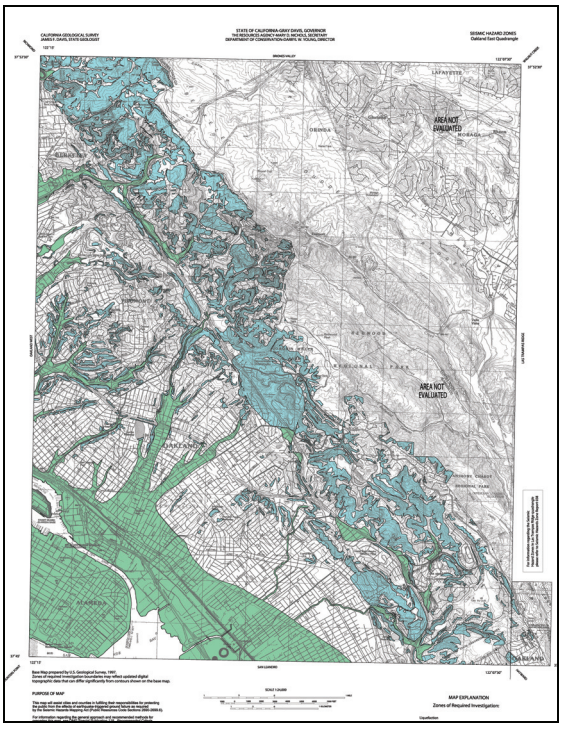

Figure A1. Seismic Hazards Zone Map – Oakland East Quadrangle

Zones of probable landslides resulting from an earthquake, are shown as blue areas. Liquefaction zones are represented as green areas. Creating this simple GIS map from complex data, requires more capability than needed to operate the Microsoft Office suit of business software products.

An important aspect of making a GIS map, is that the features to be shown, exist as elements in a database. The shapes or polygons shown on the map, are constructed by the software from graphical elements contained in a database. This requires a workstation capable of creating polygons representing abstract data, and then combine data and display a large file on a screen.

A critical aspect of all maps, is to correctly locate information in relationship to its surroundings. A map projection or coordinate transformation is a precise and demanding series of calculations. To create a map such as this, in a timely manner, requires a faster processor than for PowerPoint.

Mid Range Example

Figure A2 is a representation of the work-flow and analysis required to analyze and identify areas for which slope failure, or a landslide, could occur in the event of an earthquake.

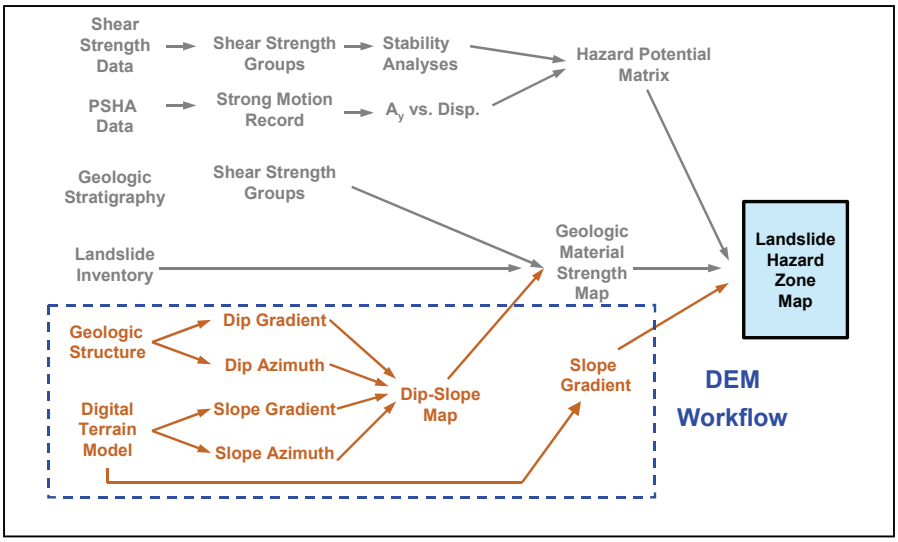

Figure A2. Generalized Workflow for Analysis of Landslide Zones

Another way to illustrate this same workflow, is by using individual maps produced for the major sub-tasks involved and then the resultant final or composite map, this is shown in Figure A3.

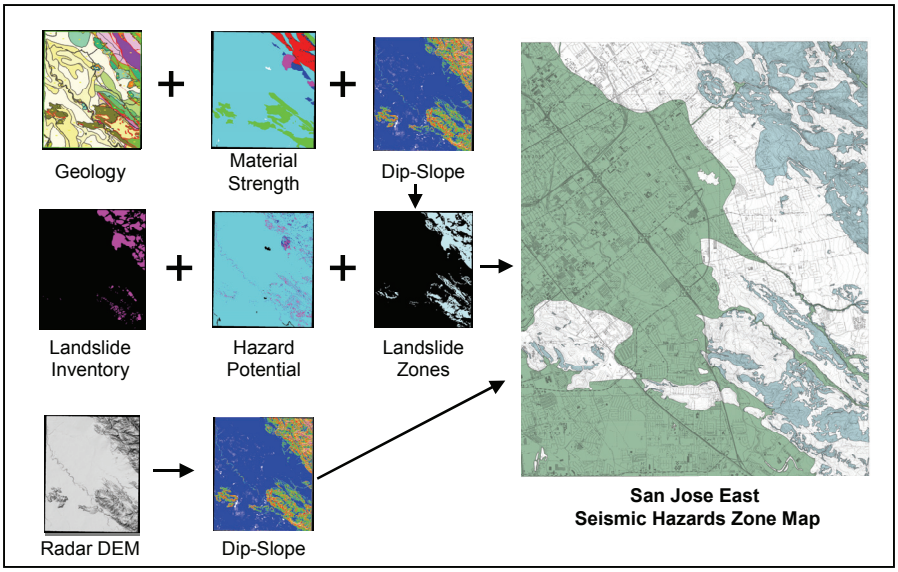

Figure A3. Graphical Representation of Landslide Zone Analysis

A more capable CPU, additional memory along with additional disk space are the most common requirements for a mid-range GIS workstation. It must be capable of managing large volumes of data and to process this data using complex topological operations. Error correcting memory is an essential requirement, otherwise intensive compute operations may fail to complete successfully, requiring retry-after-retry. A graphics card with more memory (256 to 512 MB) can be required to speed up image display and save time when displaying large graphical files.

High Performance Workstation Tasks

Tasks requiring higher performance are often the sum of many elements, combined to visualize or understand complex information. Modeling uses original data elements, not the resultant maps.

The 3-D models in Figure A4 and A5, were created by combining data elements from 160 maps containing landslide, liquefaction and surface fault data. The data were then overlaid onto U.S. Geological Survey base maps, all which were then draped onto a digital elevation model (DEM).

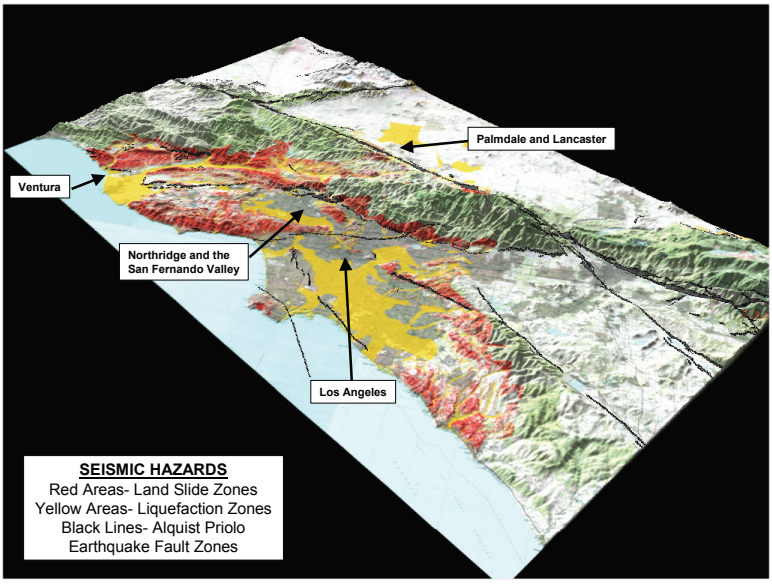

Figure A4. Seismic Hazards in Los Angeles and Vicinity

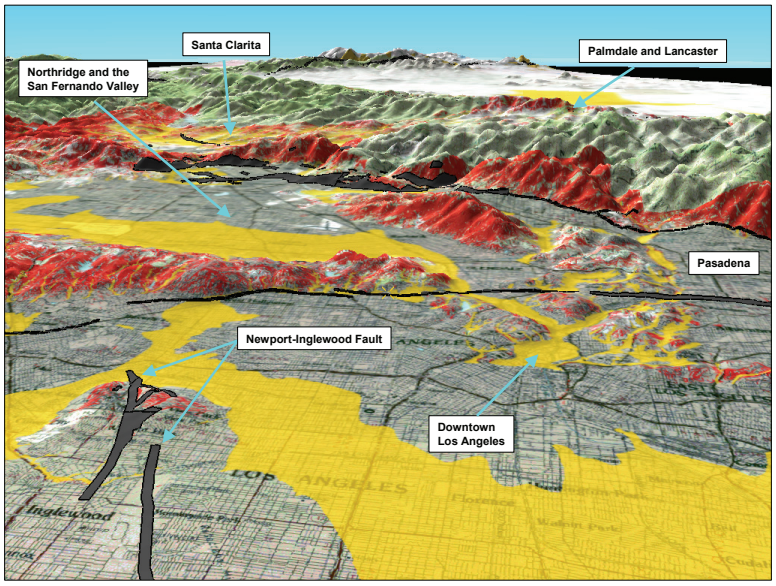

Figure A5. Close-up of Los Angeles and the San Fernando Valley

A high performance workstation was required to process two gigabytes of data in memory. Compute times required up to 14 hours. The visualization software required a 512 MB graphics card supporting Open GL subroutines. About 23 gigabytes of hard disk space was required for the data and working files. To attempt this using a mid-level workstation, would not be feasible.

Appendix D

MANUFACTURES REFERENCES FOR GRAPHICS CARDS

REFERENCES

Links to the manufactures graphics cards and system requirements are provided rather than include additional documents and pages that would make the report longer.

1. ESRI ArcGIS 3-D Analyst

http://downloads.esri.com/support/whitepapers/ao_/3d_analyst_graphics_accelerator1.pdf1.

2. Leica Photogrammetry Suite System Requirements

http://www.gis.leica-geosystems.com/products/lps/documents/lpsspecifications_0105.pdf

3. Stereographic Graphics

http://www.stereographics.com/support/boards/graphics_card_query.asp

CERTIFICATION

An important factor in choosing a graphics card for a certain software application, is that successful operation should be determined in the workstation to be used. Also the computer, graphics card and software manufactures should agree that their components will successfully work together.

Simply adding a high performance graphics card to an existing workstation can be problematic. This has been proven time-and-again to present one difficulty after another to an add-on user.

High performance components require cooperative engineering by the manufactures, that is the manufacture of the computer needs to work in concert with the graphics card manufacture, and the software manufacture needs to be satisfied that their software successfully operates in a particular graphics card/workstation combination.

Certification is not just an indication of a component working after one test.

Certification should include and provide the user with:

- follow-on support;
- maintenance; and,
- warranty.

Anything less almost always results in one manufacture pointing the problem to another.